

## Introduction

The primary mission of the U.S. Army is to fight and win the Nation's wars and protect its vital interests. The Army conducts a wider array of missions and is deployed in more areas than in any time in recent history. Recognizing this, the Army's recent vision statement says, "We will provide to the Nation an array of deployable, agile, versatile, lethal, survivable, and sustainable formations, which are affordable and capable of reversing the conditions of human suffering and resolving conflicts decisively." The key to the Army's transformation is to maintain technological dominance and to leverage emerging technologies available in the commercial market. Soldiers, the most important Army resource, should be enabled, not encumbered by the explosion of new technologies. The correct technology in the hands of well-trained soldiers and combat leaders facilitates mission accomplishment.

The Army maintains its technological edge by partnering with industry and academia. Agile, free-thinking, small (fewer than 500 employees), high-tech companies often generate innovative and significant solutions to meet soldiers' needs. The Army seeks to harness these talents through three innovative research and development (R&D) programs: the Small Business Innovation Research (SBIR) Program, the Small Business Technology Transfer (STTR) Program, and the Advanced Concepts and Technology II (ACT II) Program.

The SBIR and STTR Programs involve small businesses in early-stage R&D projects. These two programs provide timely investment capital, enabling small businesses to rapidly develop dual-use technologies, products, and services to bring to the marketplace. Dual-use technologies are defined as those that, first and foremost, benefit the soldier and are commercially viable.

The ACT II Program encourages businesses of all sizes to apply technologies that are mature, or those that are reaching maturity in the commercial sector, to address Army mission needs. Ultimately, the Army SBIR, STTR, and ACT II Programs benefit the Army, the private sector, and the national

# ADDRESSING SOLDIER NEEDS THROUGH INNOVATIVE PARTNERSHIPS

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economy. Brief descriptions of each of these programs follow.

## SBIR Program

In 1982, the U.S. Congress established the SBIR Program in response to growing concerns in the late 1970s and early 1980s about the underrepresentation of U.S. small businesses in federal R&D. Since that time, the purpose of the SBIR Program has been to increase the participation of small businesses in federal R&D. Currently, the Army must reserve 2.5 percent of its extramural R&D budget (that part of the R&D budget that goes "out of house" for contracts to private companies) for competitively selected SBIR awards to small businesses. The goal of the dual-use SBIR Program is to tap into the innovation and creativity of the small-business community to help meet Army R&D objectives. As an added incentive, these small companies simultaneously develop technologies, products, and services that can be commercialized through sales in the private sector or sales to the government (e.g., the Army).

Successful SBIR projects move through three phases. Army scientists and engineers develop SBIR solicitation topics that address current and anticipated warfighting technology needs. These topics are subjected to rigorous reviews by the U.S. Army Training and

Doctrine Command (TRADOC) Battle Labs and the Army logistics community. Senior DOD R&D managers also review the topics for compliance with national defense priorities and requirements. Small businesses enter the SBIR process by submitting concepts in the form of Phase I proposals against these topics.

Phase I is the entry point where a company receives up to \$70,000 for 6 months to prove the feasibility of its concept. An option for a company to receive up to \$50,000 is available to fund interim Phase I/Phase II activities if the project is selected to receive a Phase II award. Phase II is a substantial R&D effort where a company gets up to \$730,000 for 2 years to develop a dual-use technology, product, or service. SBIR is very competitive; about 1 in 10 Phase I and 1 in 3 Phase II proposals are selected for an award.

Phase III, the commercialization phase, is the goal of every SBIR effort. During Phase III, the successful company markets its dual-use product or service to the government, the private sector, or both. No SBIR funding is provided in Phase III.

The Army participates with the Navy, Air Force, and six other DOD agencies under the overall DOD SBIR Program; however, as is the case with the other DOD components, the Army program is autonomously managed and seeks to support Army-specific goals

within the framework of the DOD SBIR Program.

### **STTR Program**

The STTR Program, like the SBIR Program, is a government-wide program that was Congressionally mandated by the Small Business Research and Development Enhancement Act of 1992 in response to concerns raised by the U.S. academic community.

The STTR Program shares the same objectives as the SBIR Program regarding increased involvement of small businesses in federal R&D and the commercialization of innovative technologies. STTR projects also require participation by universities and colleges, several so-called Federally Funded Research and Development Centers (FFRDCs) (such as the U.S. Department of Energy's national labs), and certain other nonprofit research institutions.

Specifically, the STTR Program provides an incentive for partnering small companies and researchers at academic institutions, FFRDCs, and nonprofit research institutions to move emerging technical ideas from the laboratory to the marketplace. Each STTR proposal must be submitted by a team that includes a small business (as the prime contractor for contracting purposes) and at least one research institution, which have entered into a written agreement for the STTR effort. Also, the project must be divided so the small business performs at least 40 percent of the work and the research institution(s) performs at least 30 percent of the work. The remainder of the work may be performed by either party or a third party. The STTR budget is determined by an assessment of 0.15 percent of the Army's extramural R&D budget.

STTR moves through a three-phase process similar to that of the SBIR Program. By law, STTR Phase I can be up to a 1-year effort with a maximum contract value of \$100,000. However, Phase I efforts are currently limited to 6 months, but still valued at \$100,000. Phase II STTR projects are 2-year efforts involving an award of up to \$500,000. Because of the strong focus on forming partnerships among academia and other nonprofit research institutions, the Army Research Laboratory's (ARL's) Army Research Office (ARO), the Army's

lead agency for funding academic research, is the executive agent for the STTR Program.

### **ACT II Program**

The ACT II Program was established in 1994 by the then Assistant Secretary of the Army for Research, Development and Acquisition (now the Assistant Secretary for Acquisition, Logistics and Technology). The ACT II Program sponsors projects that would not otherwise be supported under the traditional Army R&D mission because of risk, unconventional approach, or lack of funded efforts. Each year, the Army selects industry's most promising technologies, prototypes, and nondevelopmental items for realistic demonstrations, in most cases with operational Army units, and then assesses the results. The ACT II Program, as an example of recent U.S. federal reform initiatives, represents one of the most responsive acquisition strategies in the U.S. Army. Again, the ACT II Program is open to all U.S. businesses.

Using a two-stage selection process designed to minimize the burden on industry, the Army first solicits two-page ACT II concept papers responding to mission requirements. Second, those firms providing the most promising concepts, as judged by the TRADOC Battle Laboratories and Army materiel developers, are invited to submit full proposals. Firms submitting successful proposals are awarded ACT II contracts to demonstrate their solutions to the Battle Laboratories in environments that address rigorous battlefield conditions.

Successful ACT II technology solutions then enter the Army's traditional R&D program, are selected for consideration for support by the Army Warfighter Rapid Acquisition Program, or transition directly to end items as new starts or product improvements. The annual ACT II Program budget of \$10-20 million targets 12-month projects costing a maximum of \$1.5 million each. The goal is to develop demonstration projects to meet Army requirements.

### **Conclusion**

The Army SBIR, STTR, and ACT II Programs involve aggressive outreach

efforts to "get the word out" to the commercial marketplace regarding opportunities to help the Army meet its mission needs. In part, the Army gets the word out through participation in national, regional, and local conferences with industry across the United States. Additionally, the Army has gone to great lengths to provide online access to comprehensive information about these programs via the World Wide Web. For more information about these programs, visit the ARO-Washington (ARO-W) Web site at <http://www.aro.army.mil/arowash/rt>. Administered by ARL's ARO, these programs have proven to be an integral part of the U.S. Army's successful commitment to invest in today's emerging developmental and "off-the-shelf" technologies to give our soldiers the advantages they need.

*Note: An article on the 2000 Army SBIR Phase II Quality Awards begins on Page 22 of this magazine.*

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## Introduction

Although May 2000 was ordinary by most standards, it was extraordinary for the U.S. Army Operational Test Command's Air Defense Artillery Test Directorate. During the PATRIOT Advanced Capability-Phase 3 (PAC-3) Limited User Test (LUT) conducted at Fort Bliss, TX, simulation was the main vehicle in an air defense operational test. Over the course of approximately 4 weeks of testing, crews of the test player unit, the 2nd Battalion, 1st Air Defense Artillery Regiment, engaged multiple simulated air breathing threat (ABT) and tactical ballistic missile (TBM) targets in 120 realistic threat air battle scenarios. During this phase of operational testing, not a single live aircraft or missile took to flight. At the same time, however, all testing was effective in terms of data adequacy and cost reduction. In fact, with simulation at the helm via the PAC-3 Mobile Flight Mission Simulator (MFMS) test tool, the cumulative cost of creating and engaging the enemy totaled approximately \$600,000—less than the cost of firing a single PATRIOT missile.

## The MFMS Tool

At first glance, the MFMS appears to be an ordinary military vehicle, but its capabilities extend far beyond that. The PAC-3 MFMS is a hardware-in-the-loop test system for PATRIOT that can simulate a variety of enemy air vehicles through pre-programmed threat air battle scenarios. These threats include various types of TBMs, ABTs, and air-to-surface missiles. The threat targets have programmable arrival times and designated ground impact points that require the PATRIOT system to engage multiple targets simultaneously. The scenarios are not a random generation of targets but rather a true-to-life representation of known PATRIOT threats across the globe. This feature significantly increases the realism factor of the air battle in each developed scenario.

While the mobility aspect of the simulator is relatively new, the origins of the system are not. The Raytheon

# SIMULATIONS: CHANGING THE PARADIGM FOR OPERATIONAL TESTING

CPT Andrew E. Yuliano

Corp. PATRIOT Program Office originated the flight mission simulator (FMS) in 1974 to create a tool for engineering and development. Eventually, Raytheon intended to use the FMS tool for system developmental testing. The goal was to exercise and test the PATRIOT system without altering its tactical configuration. The fire unit equipment was set in normal configuration and connected via the PATRIOT radar to the FMS for artificial target insertion. Initial success came later that year when the first version of the FMS was able to inject radio frequency (RF) signals into the system radar for one simulated target. Within 4 years, the FMS had the capability to stimulate the radar with up to 10 targets. Numerous software and hardware improvements have followed. The test tool is now capable of stimulating the PATRIOT system with the maximum number of targets allowed by the tactical system software.

Raytheon added mobility in 1995 by creating a truck-mounted FMS—this was the evolution of the MFMS.

Although engineering, development, and testing were the original goals of the FMS, this mobility allowed increased flexibility for use in operational testing. After an extensive verification, validation, and accreditation process, the MFMS was certified as a viable test tool.

The engagement control station (ECS) is tactically hard-wired to the radar set (RS), and the RS is hard-wired to the MFMS. Additionally, the communications relay group (CRG) van is linked by wire to the ECS. The Information Coordination Central communicates with the ECS

via the tactical PATRIOT Digital Information Link and communicates with the Communications, Control, and Command Engineering Environment System (a communications simulator) via Tactical Digital Information Link-J (TADIL-J). This emulates a joint defense network and ensures the system is capable of communicating in a joint environment via the TADIL-J messaging system.

The Battery Maintenance Center wires into the ECS to collect system maintenance and status data via its remote maintenance monitor on the PATRIOT Automated Logistics System computer. Simulating the PATRIOT launching stations are two data transfer units (DTUs). One DTU in the ECS simulates local launchers. The other DTU, located in the CRG, simulates remote launchers which, in reality, may be located 10-30 kilometers from the rest of the fire unit.

To create the scripted targets for each scenario, the MFMS stimulates the RS by inserting the RF signals necessary to emulate an actual track of that type



*Mobile Flight  
Mission  
Simulator*

in the RS search sector. When the radar is operating in "active radiate" mode, a combination of both MFMS-generated and real tracks will appear on the PATRIOT man stations (operator scopes). Visually, the graphic representations of MFMS tracks are no different than those of actual tracks. The operator can differentiate between real and simulated tracks by observing the identification friend or foe (IFF) response of the track if it has a working IFF system. Simply stated, a real aircraft will generate an interrogation response, whereas the simulated aircraft will return no response.

### Why Simulation?

Testing of any new or upgraded system entails two inevitable requirements. First, testing must accurately mirror the system's operational environment as it would exist during a wartime mission. Second, and perhaps more challenging, is that the first requirement must support the data collection required for system evaluation and the corresponding test schedule. In the case of the PAC-3 system, the absolute best test environment would be one of multiple live TBM, ABT, and ASM targets in flight while being tracked and engaged by a mix of live PATRIOT missiles (PAC-2, Guidance Enhanced Missile, PAC-3, etc.). This meets the first requirement as it mirrors PATRIOT operations in a wartime environment. The stumbling block is that costs would be monumental. With live missiles and aircraft flights as costly as they are, simulation is the natural alternative. Additionally, the continued proliferation of threat TBMs since Operation Desert Storm makes the development of accurate threat representative targets even more costly and challenging. The one simulation tool that effectively satisfies much of the two operational testing requirements for PAC-3 is the MFMS.

### The Bottom Line

The basic costs between a live PATRIOT missile firing and use of an



*PATRIOT radar and MFMS configured for operation*

MFMS differ immensely. Based on PAC-3 FY01 live-fire test projected costs, the funding required to fire a single PATRIOT missile at White Sands Missile Range, NM, is approximately \$2 million plus the cost of the interceptor and target. This primarily includes firing range time and equipment maintenance. Because of the close proximity of White Sands to Fort Bliss, equipment transportation is not costly. However, live missile firings at alternate locations, such as the Kwajalein Missile Range in the South Pacific, require up to three times the funding because of increased transportation and range operation costs. Additionally, the following factors cause overall costs to rise even further:

- Research and developmental testing of the target missile flight profile,
- Multiple types of target missiles and target aircraft required,
- Extensive aircraft flying time required, and
- Significant wear and tear on the system as a result of live-missile firings mandate extra repair parts and maintenance personnel.

Based on PAC-3 LUT figures, the cost of one MFMS scenario with 8 to 30 simulated target engagements is approximately \$45,000. This includes operational costs of the equipment and creation, verification, and validation of the scenario for target adequacy. Significant resource conservation is a direct result of factors such as the following:

- Simpler and more cost-effective verification and validation of target flight profile for both missiles and aircraft; threat missile motion modeling is easier than reproducing a real flying vehicle.
- Significantly less system wear and tear and maintenance personnel requirements.
- No physical reloads.
- No flying-time requirements.

### Lessons Learned

The success of PAC-3 LUTs reinforces the feasibility of simulation in operational testing. The MFMS test tool allows for required data collection and enables conservation of multiple resources. With test costs always a factor throughout the projected fielding and evaluation of any system, funding consistently weighs heavily on the mind of any test officer. The MFMS has demonstrated a proven capability to correctly simulate the flight of threat aerial vehicles that allows the operational tester to collect system performance data. Additionally, the only critical limitations of the MFMS are the inability to simulate clutter and to stimulate more than one fire unit at a time. The FMS is also unable to adequately simulate missile performance and lethality, thus necessitating hardware-in-the-loop, a flight test program, and other performance analysis tools. Despite these shortcomings, it is an outstanding tool that has lifted strains on funding, personnel requirements, and man-hours for the PATRIOT system. The contributions of the MFMS will allow for continued usage as a paradigm of a successful operational testing alternative.

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